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(54) Method of joining a sleeve to a pipe

(57) Method for tightly jointing a sleeve 1 to a submarine pipe 2 laid on very deep sea-bottom, characterized by the preliminary stages of providing a series of grooves 4 on the inside surface of the sleeve, and of filling each one of said grooves with two half-rings (6) made of a material collapsible under high pressures with up to a 70% variation of its volume. The material may comprise glass spheres bonded together by an epoxy resin.

Fig.3

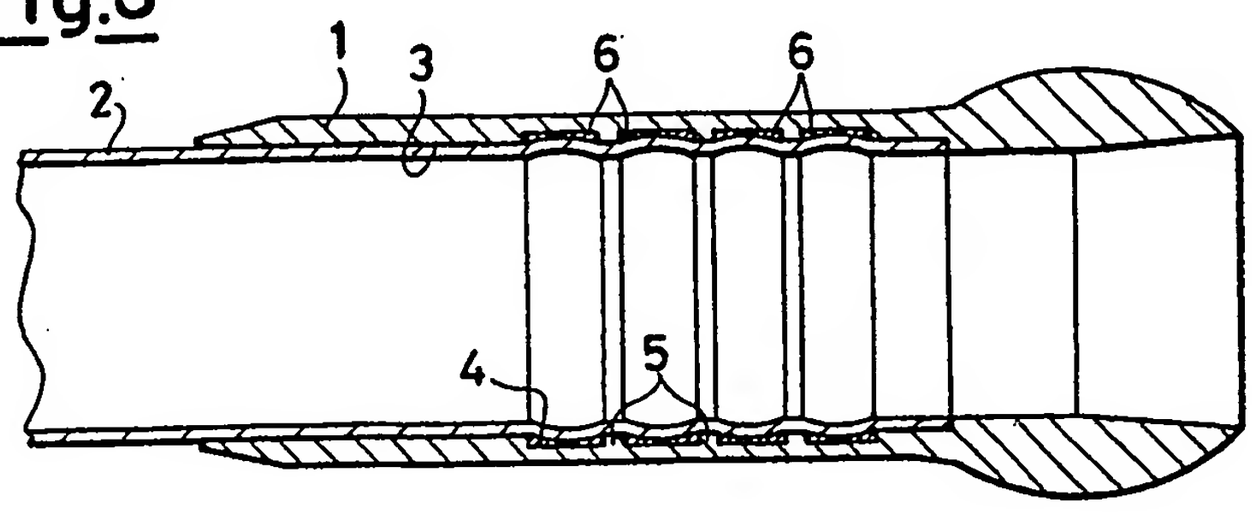

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Fig.1

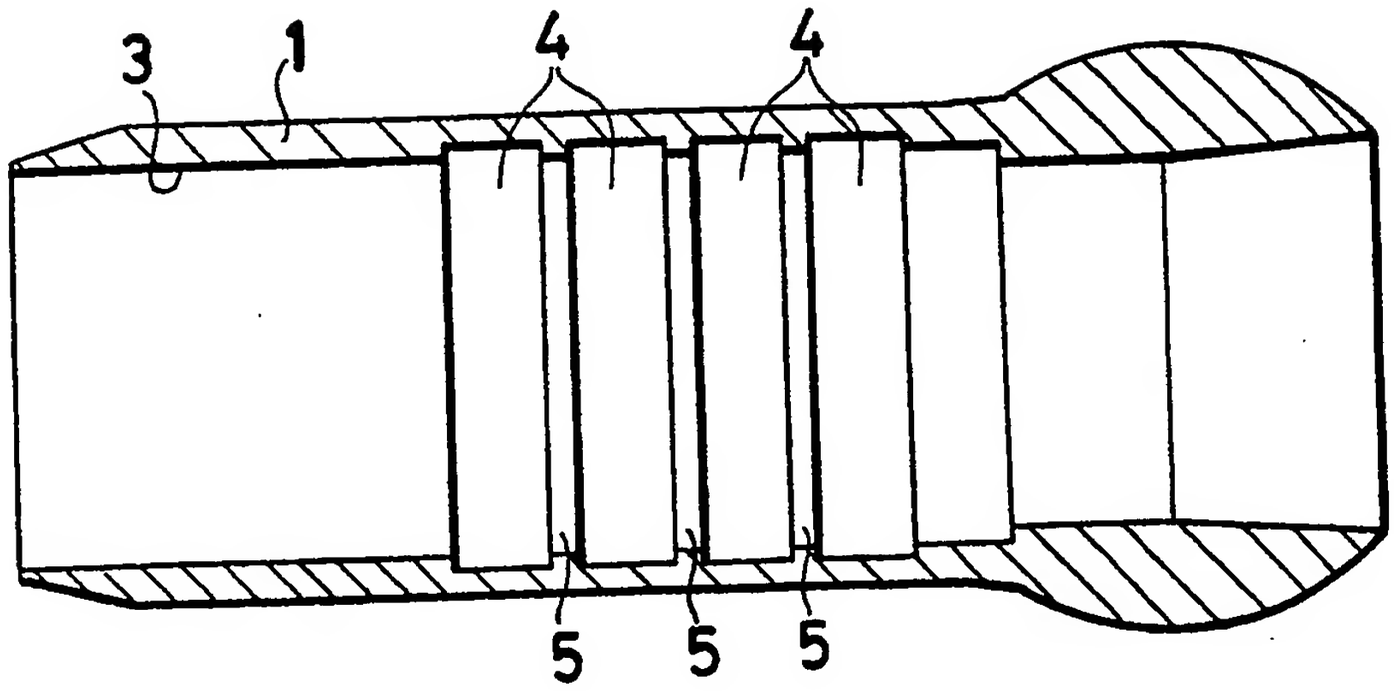


Fig.2

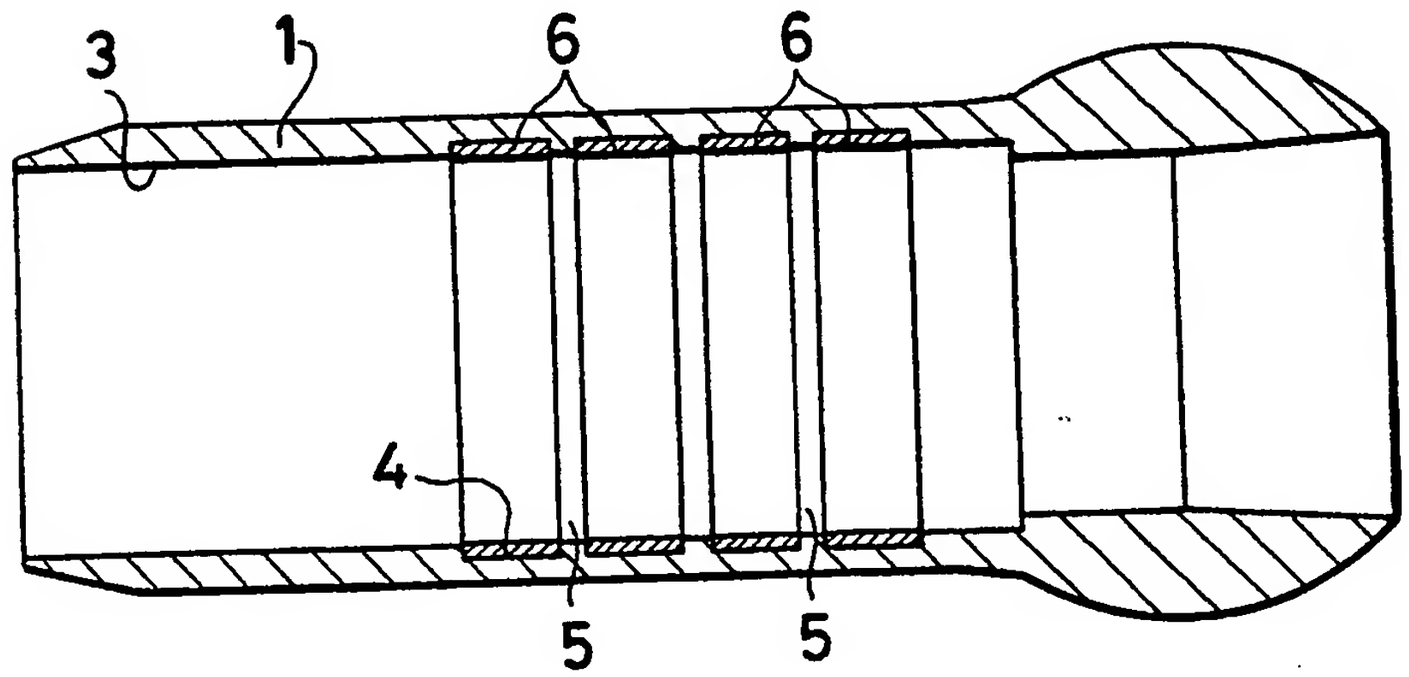
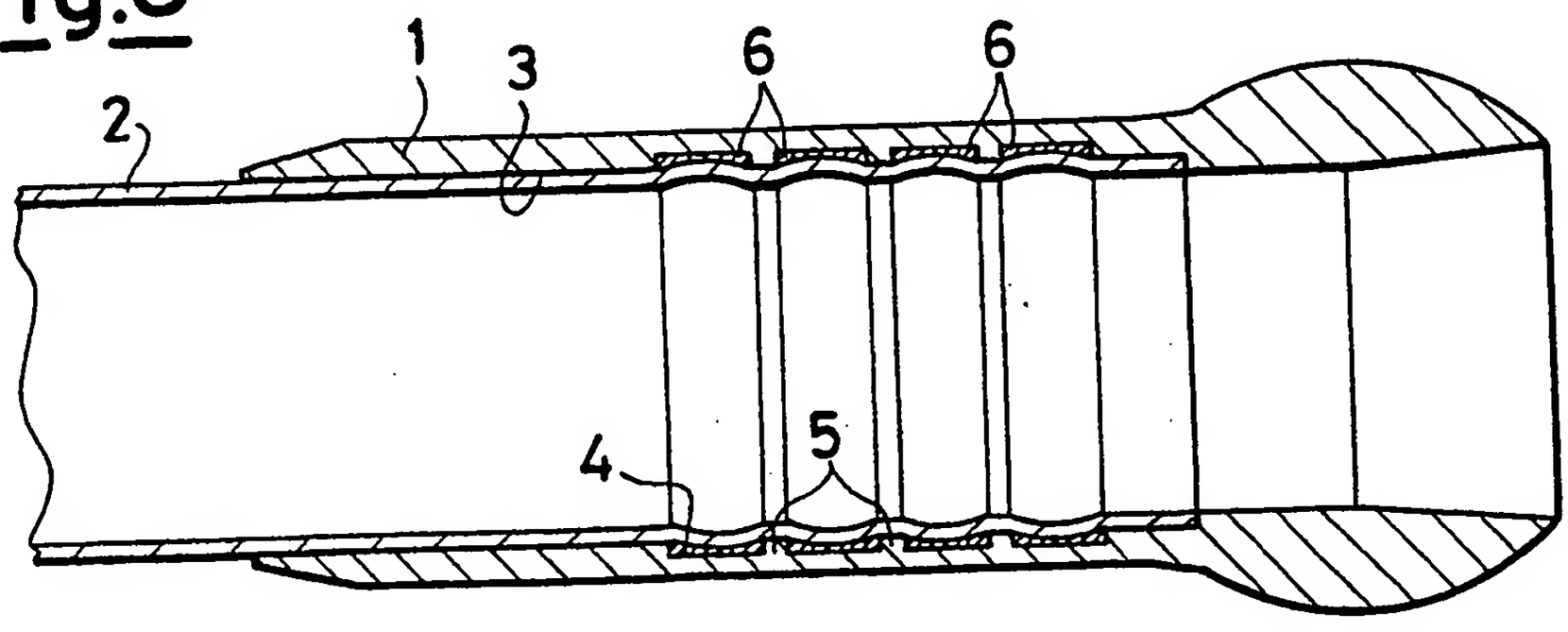


Fig.3



SPECIFICATION

Method of joining a sleeve to a pipe

The present invention relates to a novel method allowing a more effective and cheap tight jointing between a sleeve and a submarine pipe laid at a great depth. More specifically, the invention relates to an improvement to the method already disclosed in our prior U.K. Patent No. 2074914 granted on November 16, 1983.

It is known that, according to the method of said Patent, the tight fastening of a cylindrical sleeve of constant cross-section area to a steel pipe comprises the successive steps of inserting inside the overlapped pipe-sleeve assembly a particular plug expander of hard rubber, of axially compressing said plug in order to radially expand said pipe-sleeve assembly up to the limit of elastic of the material constituting the sleeve, which is higher than that of the pipe, and of decompressing and extracting said plug from said pipe.

It is clear now that if it were possible to adopt, instead of a cylindrical sleeve of constant cross-section area, a cylindrical sleeve having its inner surface shaped with a series of grooves and of toothings, the double result of a more effective and cheap tight jointing between the sleeve and the pipe would be accomplished.

In fact, during the said radial expansion the pipe would penetrate into the grooves of the sleeve, and would hence remain fastened to this latter, thus considerably enhancing the resistance to the axial thrusts, which in the case of a cylindrical sleeve with constant section is entrusted to friction only.

On the other hand, whilst in the case of the cylindrical sleeve with constant cross section area the pipe must be submitted to mechanical machining before the jointing, in order to remove the outer longitudinal welding bead, whose presence would compromise the tightness, in the case of the sleeve provided with a toothing this would not occur, in that the outer welding bead would get squashed against the edge of the teeth: the mechanical turning of the submarine pipe would thus be avoided, which is very difficult to be done in case of very great depths and requires therefore long times and high expenses.

Unfortunately, in the high depth submarine applications, the said adoption is made impossible by the high pressure of the water present in the slots, which prevents the pipe from expanding into said slots.

A m thod which would allow a cylindrical sleeve of not constant cross section area to be adopted could consists in providing holes in correspondence of the slots of the sleeve, in order to allow the outflow of the water during the expansion of the pipe, but such a solution would weaken the sleeve and consequently would considerably decrease the tightness safety.

Purpose of the present invention is precisely to [illegible] the said drawbacks, and hence to supply a cylindrical sleeve whose inside surface is provide with grooves.

This is substantially accomplished by the fact that each groove of the sleeve is preliminarily filled with two half-rings of a material which, while being practically indeformable, or only negligibly deformable under normal pressures, collapses under high pressures of the order of 300 kg/cm², with a drastic reduction of its volume, higher than 70%.

According to the present invention, there is provided a method of joining a sleeve to a pipe such as a submarine pipe laid at great depth, which comprises mounting the sleeve on a free end of said pipe, inserting a plug expander inside the pipe-sleeve assembly, axially compressing said plug in order to radially expand said pipe-sleeve assembly up to the limit of elastic deformation of the material constituting the sleeve (which limit is greater than that of the pipe), and decompressing and extracting said plug from said pipe; wherein the inner surface of the sleeve has a sequence of grooves and toothings each groove of which contains two half-rings made of a material which is substantially non-deformable under normal pressure but collapses with a reduction greater than 70% of its volume under a pressure of the order of 300 kg/cm².

In such a way indeed, as the operating pressure in the step of pipe-to-sleeve coupling is of the order of 1.000 kg/cm², the two half-rings filling each groove collapse, become more compact notably decreasing in volume and hallow hence the expansion of the pipe into the grooves.

Thus, the method for tightly jointing a sleeve to a submarine pipe laid at great depth, comprising the successive steps of mounting the sleeve on the free end of said pipe, of inserting a particular plug expander of hard rubber inside the pipe-sleeve assembly, of axially compressing and continuing to axially compress said plug in order to radially expanding the said pipe-sleeve assembly up to the limit of elastic deformation of the material constituting the sleeve, which is greater than that of the pipe, and of decompressing and extracting said plug from said pipe, is characterized, according to the present invention, by the preliminar steps of shaping the inner surface of the sleeve with a sequence of grooves and of toothings, as well as of filling each groove of the sleeve with two half-rings made with a material which is practically indeformable or deformable to a practically negligible extent under normal pressures, but collapses with a drastic reduction, greater than 70%, of its volume, under high pressures of the order of 300 kg/cm².

Now, the use according to the invention of a sleeve provided with a toothing involves a machining of the inner surface of said sleeve, but said machining is clearly easy and not very expensive in that, to the contrary of the operation of mechanical turning of the submarine pipe, it can be comfortably carried out at the surface, within premises equipped with suitable means.

According to a further feature of the present invention, the material collapsible under high pres-

half-rings are made, is constituted by glass micro- and macrospheres, with are compacted together by an epoxy resin.

It is substantially the cavity volume of said spheres and in particular of said macrospheres, which, when the material collapses, allows the large volume reduction said.

It is then clear that by using such a material, any shapes and dimensions can be accomplished, by using moulds within which the spheres and the epoxy resin are poured before hardening. Moreover, the characteristics of the material can be easily changed as a function of the installation pressure and of the collapse pressure required, by simply changing the type of epoxy resin, the size of the glass spheres, and the percentage by number of the micro- and of the macrospheres.

The invention is now clarified to a greater extent with reference to the attached drawing, illustrating a preferred embodiment of the invention, shown to exemplifying purposes only, and not to limitative purposes, in that it will be always possible to introduce technical, technological and structural changes within the spirit of the present invention.

In said drawing:

Figure 1 shows a sectional view of a sleeve according to the invention;

Figure 2 shows a sectional view of the sleeve of Figure 1, wherein the grooves are filled with half-rings always according to the invention;

Figure 3 shows a sectional view of the sleeve of Figure 1 jointed to a pipe according to the method of the present invention.

Referring to the figures, with 1 there is shown a sleeve to be tightly jointed to a submarine pipe 2 laid at a great depth.

To that purpose, on the inner surface 3 of said sleeve made of material having an elastic deformation limit greater than that of the material from which the pipe 2 is made, a set of grooves 4 and of toothings 5 is provided, and each groove 4 is subsequently filled with two half-rings 6 (see specifically Figure 2, wherein only a half-ring per each groove is visualized, the other half-ring being positioned so as to face the first one).

Said half-rings 6 are made from a material constituted by internally hollow glass micro- and macrospheres, which are compacted with each other by means of an epoxy resin poured into a mould having the shape of a half-ring.

The so-prepared sleeve is then lowered down onto the very deep sea-bottom and mounted on the free end of said submarine pipe 2. The pipe-sleeve assembly is then radially expanded, by means of a particular expander inserted inside said assembly, up the the elastic deformation limit of the material constituting said sleeve 1, so that the pipe 2 is plastically deformed into the grooves 4 of the sleeve 1 (see Figure 3), this being possible in that the half-rings 6, by collapsing due to the high-pressure conditions, reduce their volume by a considerable extent.

At last, the expander is de-energized and re-

CLAIMS

1. A method of joining a sleeve to a pipe such as a submarine pipe laid at great depth, which comprises mounting the sleeve on a free end of said pipe, inserting a plug expander inside the pipe-sleeve assembly, axially compressing said plug in order to radially expand said pipe-sleeve assembly up to the limit of elastic deformation of the material constituting the sleeve (which limit is greater than that of the pipe), and decompressing and extracting said plug from said pipe; wherein the inner surface of the sleeve has a sequence of grooves and toothings each groove of which contains two half-rings made of a material which is substantially non-deformable under normal pressure but collapses with a reduction greater than 70% of its volume under a pressure of the order of 300 kg/cm².

2. A method according to claim 1, wherein said material collapsible under pressure comprises hollow glass microspheres and macrospheres embedded in a resin such as an epoxy resin.

3. A method according to claim 1 or 2, wherein said expander is an expander as defined in claim 1 of GB-B-2074914.

4. A method of joining a sleeve to a pipe, substantially as hereinbefore described with reference to, and as shown in, the drawings.

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